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BACTERIAL COUNTS OF MILK AS AFFECTED BY SOME MILK-PLANT PRACTICES

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INTRODUCTION

The bacterial count of market milk and factors affecting its control in milk plants are important to milk-plant operators. More and more operators are paying attention to those factors that affect the bacterial count of the finished product, some because of their personal pride in the classes or grades of milk which they produce and are responsible for and others because of the fact that milk consumers throughout the country are becoming more insistent in demanding high quality in their milk products. In the purchase and inspection of milk the bacterial count is often used as a criterion for determining whether the milk is of ordinary or exceptional character. Many milk-control officials are relying to a great extent upon the bacterial count as a significant factor in grading or classifying milk. As a large percentage of market milk is pasteurized, the bacterial count of milk treated by this process is of special interest.

The bacterial count of pasteurized milk in the final container depends upon such factors as the quality and nature of the raw milk and the procedure used in processing the milk in each plant. The efficiency of the process is determined largely by the kind and condition of the apparatus and the methods used.

SCOPE OF INVESTIGATION

The investigation reported herein was made in order to determine, as far as possible, the effects of the various processes in a pasteurizing system upon the bacterial count of the milk.

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[2] Resigned Oct. 11, 1929.

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As temperatures used play a very important part in determining the total count of the finished product, the scope of the work included a study of temperatures used in pasteurizing, bottling, and storage of milk and their relation to bacterial counts.

Observations were made in 97 plants situated in 19 cities in 10 States and the District of Columbia. The area covered extended from New York to Alabama, and from New Jersey to Minnesota. None of the work was carried on in the winter, as it was believed that certain tests, especially those relating to storage-room temperatures, would be of little value if made in winter months.

The plants varied in construction, size, arrangement, and type of equipment used. The methods of washing and treating the equipment to kill bacteria and the processing and handling of the milk also varied. The capacity of the plants ranged from 100 to 30,000 gallons per day. Various types of pasteurizers were used. Among these were continuous-flow pasteurizers, both tank and tubular; and batch pasteurizers, some with single vat holders and others with automatic compartment holders. In some plants preheating was practiced; in others no preheating was done, the milk being heated entirely in the holder. Equipment such as heaters, preheaters, coolers, and bottle fillers varied in type and construction. The 97 plants were selected at random in the cities visited, and in many instances every plant in a city was studied. It was thought that so wide a range of plants would be representative of the industry as a whole.

PROCEDURE IN MAKING THE STUDY

Five consecutive days were spent in each plant, with one or two exceptions, and on each day one series of samples of milk was collected, making five series for each plant studied. It was believed that this procedure would give a fair or normal average for each plant studied and that if any one day's run at any plant was out of the ordinary routine or was exceptional the average results for that plant would not be noticeably affected. Each plant operator was asked not to make any changes in the methods regularly used while the study was being made.

METHOD OF SAMPLING MILK

The method used in obtaining samples was as follows: A sample of raw milk was collected at the dump tank or weigh can in the receiving room. Efforts were made to follow this same batch of milk through the entire plant to the storage room. It was not possible to get exactly the same series in every test. However, for each of the 97 plants studied, comparable series were obtained, if certain samples from certain plants were eliminated. For example, there were some plants where a run consisted of samples of milk (1) from the weigh can, (2) before it entered the filter, (3) after it had been filtered, (4) before it was preheated, (5) after it had been preheated, (6) from the pasteurizing vat or holder before pasteurization, (7) from vat after pasteurization, (8) from the top of the cooler, (9) from the bottom of the cooler, (10) from a filled bottle, and (11) from the same bottle after storage. At other plants the series of samples obtained was: (1) raw milk in vat before pasteurization, (2) hot milk from vat after pasteurization, (3) pasteurized milk from the bottom of the cooler,

(4) pasteurized milk from bottle, (5) pasteurized milk from the same bottle after storage. This latter series was obtained at each of the plants studied, and it is this series of samples for which data are presented in this circular.

In taking a set of samples, the raw milk was sampled just before being pasteurized. In plants where the milk was not preheated this sample was taken directly from the holder, and in plants where preheating was done it was taken from the raw-milk storage or from a break in the raw-milk line just in front of the preheater. After the holding period, a sample of the pasteurized milk was obtained either from the holder itself or from the first accessible point after the pasteurized milk had left the holder. Usually this point was at a valve or "break" at the holder outlet. The set was completed by taking samples of the pasteurized milk from the bottom of the cooler, from a filled bottle, and from the same bottle after it had been kept in the storage room for 24 hours. All samples were iced as taken, and immediately after the set was completed the samples were carried to the laboratory and plated for bacterial count.

PREPARATION OF SAMPLES FOR BACTERIAL COUNT

All bacterial counts were determined by the "plate count" in accordance with the standard methods for milk analysis of the American Public Health Association.[3] In order that the results of bacterial counts made in different laboratories at the various cities where the plants were situated might be as comparable as possible, the writers themselves did all the sampling, plating, and reading of plates. The media used were shipped to these laboratories from the Bureau of Dairy Industry laboratories in Washington, D. C. On account of the uniformity in methods and materials used, it is believed that the bacterial counts, even though made at various laboratories, are comparable.

GENERAL RESULTS OF THE TESTS

Table 1 gives the average bacterial counts of milk at different points in the pasteurizing system, for all of the 481 sets of samples taken at 97 plants. This table shows that after the pasteurized milk left the holder its bacterial count increased at each point where samples were procured—at the bottom of the cooler, in the bottle, and from storage. These increases were not individually large, but aggregated over 38 per cent, as compared with the bacterial count of the pasteurized milk in the holder. The bacterial count of the raw milk varied from a few thousand to millions per cubic centimeter. The data presented show that cleanliness and careful operation of every unit in a milk plant are essential if the finished product is to be low in bacteria. At every point after pasteurization, increases in bacterial count are likely to be found. Therefore careful operation and close supervision of all processes are necessary if unduly large increases in the bacterial count of the finished product are to be held in check.

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[3] AMERICAN PUBLIC HEALTH ASSOCIATION and ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. STANDARD METHODS OF MILK ANALYSIS, BACTERIOLOGICAL AND CHEMICAL . . . Ed. 5, 68 p., illus. New York. 1928.

TABLE 1.—*Average bacterial counts at various points in pasteurizing plants (481 runs)*

Description of sample	Average bacteria per cubic centimeter	Increase (+) or decrease (−) in bacterial count	
	Number	*Number*	*Per cent*
Raw milk before pasteurization	1,050,600		
Hot milk after pasteurization	28,600	−1,022,000	−97.33
Pasteurized milk from bottom of cooler	32,600	+4,000	+13.99
Pasteurized milk from bottle	36,800	+4,200	+12.88
Pasteurized milk from same bottle from storage (about 24 hours later)	39,500	+2,700	+7.34
Total increase in bacteria after pasteurization		+10,900	+38.11

In 41 sets of samples the plates made from samples of pasteurized milk showed typical pin-point colonies. In general these pin-point colonies were suggestive of the presence of a heat-resistant bacterial flora or a flora which would grow at pasteurizing temperatures. No further identification of these pin-point colonies was made.

Table 2 gives the average bacterial counts of 41 sets of samples in which pin-point colonies were found on the plates made from samples of pasteurized milk. The data in this table show that as the milk passed through the plant from the pasteurizer over the cooler, into the bottle, and out of the storage room 24 hours later, the bacterial count decreased at each point where samples were procured. This is the reverse of the findings when all the samples (481 sets) procured in this study were averaged. The total increase in bacterial count for all the samples of pasteurized milk was 38.11 per cent, as compared with a total decrease of 21.63 per cent for samples showing pin-point colonies. The percentages of decrease in bacterial counts as a result of pasteurization were 97.33 per cent for all samples (Table 1) and 93.42 per cent (Table 2) for those samples showing pin-point colonies.

TABLE 2.—*Average bacterial counts of samples of milk in which pin-point colonies were found, at different points in the pasteurizing system (41 runs)*

Description of sample	Average bacteria per cubic centimeter	Decrease in bacteria	
	Number	*Number*	*Per cent*
Raw milk, before pasteurization	1,623,200		
Hot milk after pasteurization	106,800	1,516,400	93.42
Pasteurized milk from bottom of cooler	103,700	3,100	2.90
Pasteurized milk from bottle	102,900	800	.77
Pasteurized milk from same bottle from storage (about 24 hours later)	83,700	19,200	18.66
Total decrease after pasteurization		23,100	21.63

Table 2 also indicates quite plainly that when pin-point colonies were present, storage for 24 hours reduced the bacterial count to a significant extent. The average reduction in count due to storage was 18.66 per cent.

Experimental and practical work in milk plants has shown that ordinarily a greater percentage of reduction in bacterial count of the finished product may be expected when the raw milk has a high count than when the raw milk has a low count. This general statement does not hold, however, when heat-resistant bacteria are present. The pasteurizing runs that showed pin-point colonies gave a lower pasteurizing efficiency, as judged by bacterial-count reduction, than was found when all the runs were included, even though the raw-milk count was approximately 60 per cent higher.

PASTEURIZATION TEMPERATURES AND THEIR EFFECT ON BACTERIAL COUNT

The results of this work indicate that the temperature of pasteurization has a marked effect upon the bacterial count of the pasteurized milk. In Table 3 data are presented for 469 runs, grouped according to temperatures used, which show the effect of the pasteurizing temperature upon the bacterial count. Only those runs which could be carefully checked as to temperature and which showed small variation in temperature (not over 1.5° F.) during the holding period, are given in this table. The recording or stem thermometers in use at the various plants were checked as to accuracy. Corrected temperatures are used throughout this bulletin. There was no check made upon the evenness of temperature throughout various parts of the vat. In all cases the holding period was 30 minutes.

TABLE 3.—*Effect of various temperatures of pasteurization on the reduction of the bacterial count of milk*

Runs	Pasteurizing temperature	Average bacterial count		Average decrease in bacteria per cubic centimeter	
		Raw milk	After pasteurization		
	°F.	*Number*	*Number*	*Number*	*Per cent*
12	140–141	1, 490, 900	59, 600	1, 431, 300	96. 00
96	142	967, 800	25, 600	942, 200	97. 35
111	143	938, 600	26, 300	912, 300	97. 19
130	144	1, 146, 700	29, 400	1, 117, 300	97. 44
87	145	942, 000	22, 000	920, 000	97. 66
33	146–148	764, 500	12, 700	751, 800	98. 34
469	140–148	1, 026, 300	26, 100	1, 000, 200	97. 45

The pasteurization runs are grouped according to the average temperature of pasteurization for each run. In no case did the temperature in the first group (140°–141° F.) drop below 140°. More than 50 per cent of the runs in Table 3 were made at temperatures of 143° to 144°, and 90 per cent were made at temperatures ranging from 142° to 145°, inclusive.

At pasteurizing temperatures of 140° to 141° F. the bacterial counts of the 12 runs falling in this group decreased 96 per cent on an average, as a result of pasteurization. At 142° the average decrease in bacterial count was considerably greater, being 97.35 per cent. For temperatures ranging from 142° to 145°, although the percentage of

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decrease in the bacterial count increased slightly, there was very little difference in pasteurizing efficiency. From the lowest to the highest temperatures given in Table 3, however, the reduction in bacterial count was definitely increased. Incidentally observations made during this study indicate that many plants are using recording thermometers and stem thermometers which are not accurate. Some were found to be in error from 2 to 6 degrees.

Table 4 shows the effects of temperatures of pasteurization on reduction of bacteria in the 428 runs which did not contain pin-point colonies. A comparison of Table 4 with Table 3 bears out the fact, already indicated in Tables 1 and 2, that when the runs containing pin-point colonies are eliminated, there is a larger reduction in the bacterial count during pasteurization. This holds true for all temperatures at which pasteurizing runs were made. In every instance the efficiency of pasteurization was less when pin-point runs were included.

TABLE 4.—*Effect of various temperatures of pasteurization on the reduction of the bacterial count of milk ("pin-point" samples excluded)*

Runs	Pasteurizing temperature	Average bacterial count		Average decrease in bacteria per cubic centimeter	
		Raw milk	After pasteurization		
	°*F.*	*Number*	*Number*	*Number*	*Per cent*
12	140-141	1, 490, 900	59, 600	1, 431, 300	96. 00
90	142	926, 600	19, 700	906, 900	97. 87
103	143	906, 300	21, 600	884, 700	97. 61
114	144	1, 068, 200	15, 900	1, 052, 300	98. 51
78	145	780, 900	11, 700	769, 200	98. 48
31	146-148	768, 700	10, 100	758, 600	98. 69
428	140-148	969, 100	18, 600	950, 500	98. 08

Table 4 also shows that the higher temperatures of pasteurizing milk are more effective in reducing bacterial count than the lower temperatures used in the plants studied. This was also found to be true for the 469 runs which included those containing pin-point colonies.

EFFECT OF BOTTLING ON TEMPERATURE OF MILK

In handling milk at milk plants efforts are continually being put forth to keep the milk as cold as practicable, except when it is heated during pasteurization. Any decided increase in temperature after the milk has been pasteurized and cooled may seriously affect its quality.

The increase in temperature of the milk as it passes from the bottom of the cooler, through the bottle filler, and into the bottle, was determined for each run at the 97 plants (481 samples). Various types of bottle fillers were used, and hook-ups differed in the various plants. The data presented in Table 5 represents the averages of all runs, and shows that there is a considerable and variable rise in the temperature of the milk from the time it leaves the cooler until it is put into the final container.

TABLE 5.—*Effect of filling on the temperature of milk*

Size of bottles	Plants	Bottles	Temperature of milk at bottom of cooler			Temperature of milk in bottle			Increase in temperature from cooler to bottle		
			Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average
	Number	*Number*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*
One-half pint	7	35	62	34	40.2	64	40	45.7	8.0	4.2	5.5
One pint	41	202	62	34	41.1	68	38	46.1	11.2	1.2	5.0
One quart	49	245	60	33	43.3	63	36	48.4	13.2	2.0	5.1

In all cases the temperature of the milk increased as the milk passed from the cooler through the fillers and into the bottles. The temperature of the bottled milk was read immediately after the bottles came from the fillers and a wide variation in rise of temperature during the filling process was noted. Table 5 shows that the maximum rise in temperature from cooler to bottle, measured over a period of five days, was as high as 13.2°F., whereas the minimum increase was only 1.2°.

It is not known whether the increases observed would have been still greater if the temperatures of the bottled milk had been read a few minutes after the bottle was filled instead of immediately after it was filled. The temperature of the bottle might have had more influence on the temperature of the milk placed in it if more time had elapsed between filling the bottle and reading the temperature of its contents.

It would seem from the data presented herein that operators of milk plants who find a large increase in temperature in the bottled milk over that of the milk from the cooler, could profitably give more study to preventing losses of refrigeration during the filling process.

EFFECTS OF 24-HOUR STORAGE ON PASTEURIZED MILK

The effects of temperatures in storage rooms upon the bacterial count of milk held in storage for 24 hours were studied at 49 of the plants. The results are presented in Table 6. The temperatures of the atmosphere in the storage room were recorded by means of a self-contained, 24-hour air-recording thermometer. The layout and the construction of the storage room were observed, and the thermometer was so placed that it would record, as nearly as was practicable, the average temperature at which the bulk of the retail supply of milk was stored. The bottle of milk to be sampled was hung directly on the thermometer, or placed in the immediate vicinity, thus assuring that the temperature of the air surrounding the sample would be the temperature recorded. Every 24 hours the sample was removed, and a new sample substituted, for five successive days. The average hourly temperature of the storage room was determined by averaging the temperatures recorded on the chart at hourly intervals for five consecutive days. Temperatures were taken on the hour. As brought out later in this circular, average hourly readings do not necessarily include the highest or lowest extremes of temperature recorded during the day.

TABLE 6.—*Effect of 24 hours' storage on the bacterial count of pasteurized, bottled milk*

Number of plants	Samples of milk	Average hourly temperature [1]	Average increase or decrease in count per cubic centimeter	Percentage of samples showing increase
	Number	°*F.*		*Per cent*
11	55	Less than 40	−2,163	27.2
27	135	Between 40 and 45	−587	37.0
11	55	45 and over [2]	+15,688	73.8

[1] Average for 5-day period.
[2] Highest average for 5-day period at any plant was 50.8°F.

When the pasteurized, bottled milk was stored at temperatures under 45°F. there was a reduction in average bacterial count during 24 hours of storage. At temperatures over 45° a decided average increase in count occurred. The highest average hourly temperature over a 5-day period for any plant was 50.8°.

Evidently increases or decreases in the bacterial count of milk during storage are dependent upon other factors as well as temperature. Probably the nature of the bacterial flora is significant. However, when a relatively large number of samples are considered, the average increase or decrease in the bacterial count of storage milk will be governed to a great extent by the storage temperature, and at temperatures below 45°F. a decrease in count is probable. Temperatures below 40° seem to be preferable to higher temperatures when low bacterial count is desired.

TEMPERATURES WITHIN STACKED CASES OF BOTTLED MILK IN STORAGE ROOMS

At nine plants, on 35 separate days, observations were made to determine to what extent air temperatures varied within stacked cases of bottled milk. Three maximum-minimum thermometers were placed at three different points in the stack, namely, in the bottom, middle, and top cases. Temperatures were recorded every 24 hours and the thermometers reset.

The figures given in Table 7 are averages of all the determinations made at each plant. This table shows that neither the bottom, middle, nor the top case in the stack was consistently higher in temperature than the others. Large variations occurred, but in no regular manner. The actual temperatures depend, no doubt, upon the method of cooling, the location of brine tanks or coils, and the location of doors and chutes. From these studies no definite statement can be made other than that large variations in temperature occur in the air within stacked cases. In one instance the average variation was 24°F. during the 5-day period.

TABLE 7.—*Daily average temperatures of the atmosphere in stacked cases in storage rooms, and variations throughout entire storage period*

Plant No.	Top case		Middle case		Bottom case		Variations (24 hours)			Storage period	Cases in stack
	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Top case	Middle case	Bottom case		
	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	°*F.*	*Days*	*Number*
122	51.0	36.7	49.2	38.5	48.0	37.5	14.3	10.7	10.5	4	7.5
123	53.2	37.7	51.5	37.7	48.5	36.7	15.5	13.8	11.8	4	7
134	54.6	41.8	54.6	42.2	55.2	43.2	12.8	12.4	12.0	5	5
137	55.0	46.5	54.5	46.0	54.5	45.0	8.5	8.5	9.5	2	6
138	59.0	39.0	59.0	35.0	55.0	35.5	20.0	24.0	19.5	7	7
140	50.0	42.2	49.2	43.2	49.6	42.8	7.8	6.0	6.8	5	5
144	48.0	38.8	48.0	40.2	46.8	40.2	9.2	7.8	6.6	5	5
147	55.0	43.0	57.0	45.0	56.0	41.0	12.0	12.0	15.0	1	6
149	50.0	42.5	51.0	44.0	51.0	43.5	7.5	7.0	7.5	2	6

TEMPERATURES AT DIFFERENT POINTS IN STORAGE ROOMS

Variations in atmospheric temperature at different points in cold-storage rooms, were determined at 29 of the plants. Three maximum-minimum thermometers were placed at three different points in the storage rooms. These points were chosen not with the idea of finding normal or average temperatures in the room, but so as to give temperatures of "dead air pockets," drafts, etc. In all cases, however, the location was one at which milk had been or might be stored. Temperatures were read daily.

Table 8 shows the temperature record for one individual plant. It gives the high and low temperature for each of the three thermometers and the extreme range for the whole room, on each of five successive days, and the average variation for the 5-day period.

TABLE 8.—*Maximum and minimum temperatures (°F.), at three different points in the cold-storage room of plant A*

Date (1930)	Point 1		Point 2		Point 3		Extreme range in room	
	High	Low	High	Low	High	Low	High	Low
Aug. 4	50	36	48	36	62	38	62	36
Aug. 5	50	38	50	36	58	39	58	36
Aug. 6	56	40	56	38	62	40	62	38
Aug. 7	56	40	54	38	72	40	72	38
Aug. 8	54	38	54	36	70	38	70	36
Average	53.2	38.4	52.4	36.8	64.8	39.0	64.8	36.8
Average variation for 5-day period	14.8		15.6		25.8		28.0	

The temperatures recorded in this particular room varied greatly. This held true both as to the temperature at different points within the room and as to the temperature at different times at the same point. When it is known that milk is stored in rooms with such great temperature variations and the temperature at times is far higher than that which is a safe storage temperature, efforts should be made to carefully control storage temperatures in all parts of the room. Observations made during this study have shown that more care in keeping doors and chutes of storage rooms closed, especially at the time of loading out cases of milk, and the installation of fans to keep the air in circulation, oftentimes aided materially in maintaining a lower and more even temperature in the storage room.

Table 9 shows the average variations in temperature at the three places selected in each of 29 rooms studied for a period of five days, together with the average extreme variations found in each room, and the averages for the group. There were wide differences in the range of temperatures found in different storage rooms and in individual rooms. In one storage room the average variation in the extreme temperatures observed for a period of five days was 7.8 degrees, and in another room the average extreme variation was 9.4 degrees. These two rooms may be regarded as having fairly even temperatures as compared with that of two other rooms which showed average extreme variations of 24.8 and 28 degrees, respectively.

TABLE 9.—*Average temperature (°F.) variations at three different points in each of 29 cold-storage rooms during test period*

Point A	Point B	Point C	Extreme range in cold-storage room	Test period	Point A	Point B	Point C	Extreme range in cold-storage room	Test period
				Days					*Days*
14.8	15.6	25.8	28.0	5	11.4	13.2	9.4	13.8	5
9.0	10.6	14.6	16.0	5	20.6	17.6	15.6	22.6	5
4.8	16.0	10.2	21.6	5	10.2	17.6	15.6	22.2	5
13.4	12.6	14.4	17.0	5	13.0	10.2	7.2	15.4	5
9.0	9.8	7.6	15.8	5	16.4	11.2	15.6	17.8	5
10.0	11.2	10.4	12.2	5	12.2	12.8	16.8	16.8	5
13.6	14.6	15.6	23.8	5	14.4	13.4	16.4	19.0	5
13.6	15.4	16.2	22.6	5	20.0	21.6	22.8	24.6	5
17.8	20.2	21.0	26.2	5	12.2	12.0	9.6	13.8	5
12.4	12.0	14.6	15.4	5	14.0	14.8	10.4	9.4	5
9.2	7.6	4.8	10.4	5	10.2	9.0	5.0	12.4	5
16.0	17.2	--------	18.4	5	12.7	9.7	9.6	15.3	3
16.0	12.8	13.8	19.6	5	6.4	6.0	4.2	7.8	5
7.8	8.8	21.2	21.6	5					
8.0	7.6	24.0	24.8	4	Av. 12.53	12.72	13.78	18.37	4.89
15.5	13.8	14.3	19.0	5					

From the data presented in Table 9 it is evident that in many storage rooms there were conditions of temperature which were not favorable for the proper storage of milk. Uniformity or evenness of low storage temperature is desirable. Thorough studies of temperature conditions in storage rooms might well be undertaken by milk-plant operators with considerable profit.

In order that average hourly temperatures may be properly interpreted, a study of the temperature chart of each particular storage room is necessary. It frequently was found that whereas an average hourly

temperature for 24 hours was comparatively low, well under 50° F., the temperature of the room had been over 50° for a considerable period. Under such conditions, even though the average hourly temperature fell within the accepted range for storage temperatures, the temperature during part of the time was too high for proper milk storage.

Table 10 gives data procured from several plants on charts of recording thermometers, showing that average hourly temperatures do not always mean that the condition in the storage room is at all times favorable for proper milk storage. Each milk-plant operator should carefully check up the temperatures in the storage room, both as to evenness of temperature at different places in the room and also as to uniformity on a time basis.

TABLE 10.—*Average daily temperature of storage rooms, based on hourly observations for five successive days, and the number of hours per day that the temperature was over 50° F.*

Plant No.	Date (1930)	Average temperature in storage room	Period temperature was over 50° F.	Plant No.	Date (1930)	Average temperature in storage room	Period temperature was over 50° F.
		°F.	*Hours*			*°F.*	*Hours*
121	July 1	48.1	5.5	129	July 23	52.9	11.5
121	July 2	47.0	.5	129	July 24	50.3	11.75
121	July 3	45.6	1.25	136	Aug. 2	44.1	5.0
123	July 10	50.8	10.5	136	Aug. 3	44.0	3.0
123	July 11	50.4	10.5	136	Aug. 4	45.8	8.0
123	July 12	45.3	5.25	136	Aug. 5	45.4	6.0
123	July 13	44.8	5.5	187	Aug. 12	46.3	3.5
129	July 20	48.6	3.0	187	Aug. 13	46.9	7.0
129	July 21	50.5	11.0	187	Aug. 14	48.6	7.0
129	July 22	51.7	14.5	187	Aug. 15	47.5	6.0

CONCLUSIONS

No one process can be neglected if the milk in the final container is to have a bacterial count comparable to that found in the pasteurizer.

Pasteurizing temperatures of 142° to 146° F. are more efficient in killing bacteria than temperatures of 140° to 141°.

Increases in bacterial count occur between the pasteurizer and the bottom of cooler, between the cooler and bottle, and during 24-hour storage.

Considerable refrigeration is lost during the filling process.

Storage temperatures below 40° F. are preferable to those over 40°.

Temperatures in storage rooms vary to a considerable extent, both at various points within the room and at various times of the day.

In many instances it appears that milk-plant operators might profitably study their whole refrigeration system. Refrigeration losses might be overcome or lessened at the filler and in the storage room.

Bacterial counts showing pin-point colonies tend to decrease as the milk passes through the pasteurizing plant.

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